Multimodal Agile Ranging and Velocimetry INstrument, Phase I

Completed Technology Project (2018 - 2019)

Project Introduction

We propose to investigate two new sensing modalities comprising the Multimodal Agile Ranging and Velocimetry INstrument (MARVIN) using a novel acousto-optic Structured Light Imaging Module (SLIM) previously developed under the NASA PIDDP program for planetary rover navigation and geomorphology.

Based on an acousto-optic illumination engine, SLIM consumes only 10-20W of power, weighs less than a kilogram, could fit in a shirt pocket, and uses space-proven components without moving parts to rapidly generate and precisely control laser illumination patterns.

Through modifications of SLIM hardware and algorithms, MARVIN enables triangulation-based wide-field active 3D imaging of nearby scenes with mm-scale resolution at distances up to 10m even in the presence of full sunlight, as well as multi-beam time-of-flight (ToF) cm-resolution ranging and Doppler velocimetry at distances of hundreds of meters, or potentially even further. MARVIN can switch between the two modes simply by moving a lens.

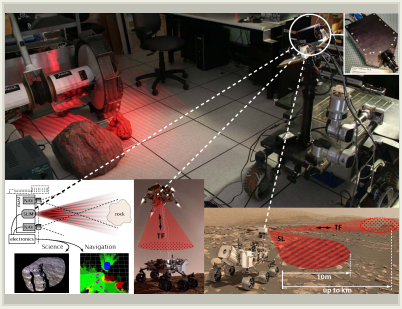
MARVIN computes each range point in parallel and independently, is robust across a wide range of ambient lighting and albedos, and is computationally simple, increasing rover autonomy day and night, and eliminating traverse and science operation down-times due to uplinks and heavy computation required by stereo vision. MARVIN can be used as a faster, more robust, high-precision primary range sensor for landed or close-proximity robotic exploration of planets and small bodies including Mars, Ocean Worlds, asteroids, comets, and planetary moons.

The proposed effort includes further feasibility and commercialization studies, algorithm development, noise and performance analysis, and a basic proof-of-concept lab demonstration of MARVIN in the near-infrared. We will also evaluate the use of telecom-wavelength sources and detectors to further improve MARVIN SNR for operation in sunlight and on icy bodies such as Europa. We believe the proposed effort will advance MARVIN from TRL2 to TRL3.

Anticipated Benefits

In addition to enhancing planetary rover mobility, MARVIN could aid instrument arm positioning and serve as an agile and versatile sensor for spacecraft landing and proximity operations, including on future human missions to Mars. An asteroid orbiter like Psyche could use MARVIN for attitude control and to map topography. As a landed science tool, MARVIN could be used to characterize geological surfaces and with telecom wavelengths, identify ice composition on Europa or detect water on Mars.

Due in part to agile illumination control, tolerance to a wide range of lighting



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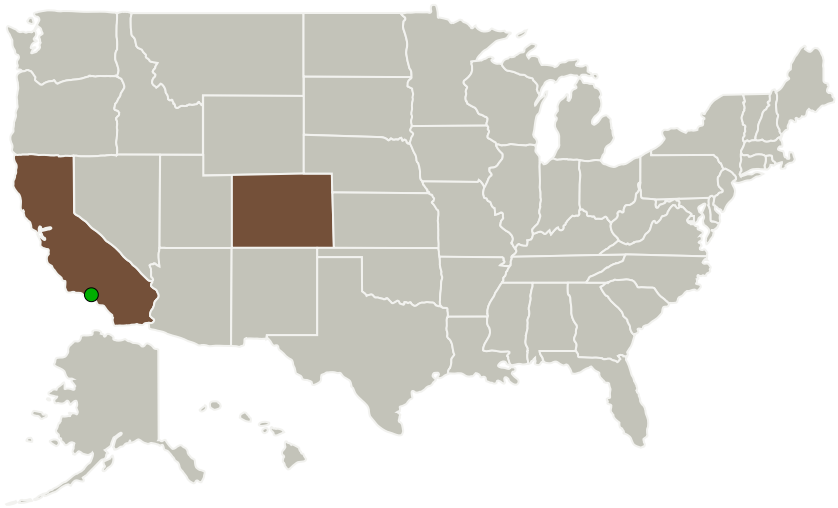
conditions, high throughput, no moving parts, as well as low size, weight, and power requirements, MARVIN and SLIM technologies could also prove transformative for a number of applications on Earth, including robotic simultaneous location and mapping (SLAM), aerial surveying and landing systems, as well as autonomous car navigation. We consider strategies for reducing costs and commercialization in the proposal.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
LambdaMetrics	Lead Organization	Industry	Boulder, Colorado
Jet Propulsion Laboratory(JPL)	Supporting Organization	NASA Center	Pasadena, California

Primary U.S. Work Locations	
California	Colorado

Project Transitions

August 2018: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

LambdaMetrics

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Principal Investigator:

Daniel Feldkhun

Co-Investigator:

Daniel Feldkhun

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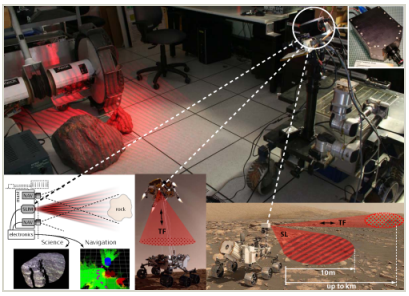
February 2019: Closed out

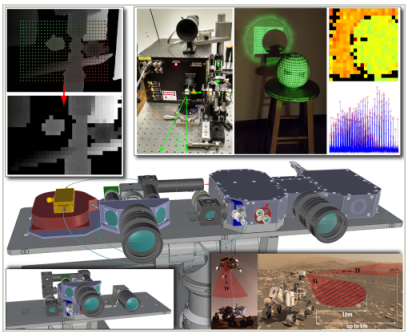
Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/141188)*

Images



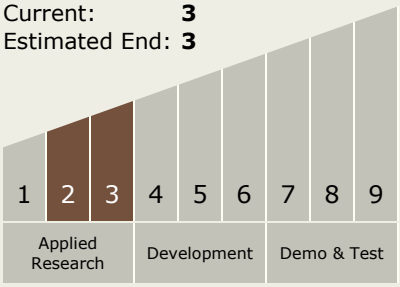
Briefing Chart Image
Multimodal Agile Ranging and Velocimetry INstrument, Phase I *(https://techport.nasa.gov/image/133363)*



Final Summary Chart Image
Multimodal Agile Ranging and Velocimetry INstrument, Phase I *(https://techport.nasa.gov/image/127515)*

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



Technology Areas

Primary:

- TX04 Robotic Systems
  - TX04.2 Mobility
    - TX04.2.4 Surface Mobility

Target Destinations

Mars, Others Inside the Solar System